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Surgical Site Infection Following Surgery for Inflammatory Bowel Disease in Patients with Clean-Contaminated Wounds

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Abstract
Background It is generally believed that the accompanying conditions in patients with inflammatory bowel disease (IBD) are associated with a high incidence of surgical site infection (SSI), and sometimes these patients are classified as compromised hosts without definitive clinical evidence. The aim of this study was to clarify the impact of IBD on the occurrence and features of SSI in patients with clean-contaminated wounds.
Methods We conducted prospective SSI surveillance of 580 patients with clean-contaminated wounds who underwent surgery between March 2006 and December 2007 using the National Nosocomial Infection Surveillance system. Multivariate analyses using stepwise logistic regression were performed to determine risk factors for SSI.
Results A total of 562 patients with clean-contaminated wounds who underwent surgery for IBD [ulcerative colitis (UC), $n = 173$; Crohn's disease (CD), $n = 122$] or colorectal cancer [(CA), $n = 267$] were identified for evaluation. SSI was observed in 12.6% of all patients and there was no significant difference in infection rate by type of disease (UC, 14.5%; CD, 13.9%; CA, 10.9%). Multivariate logistic regression analysis yielded an ASA score ≥ 3 [odds ratio (OR) = 2.04; 95% confidence interval (CI) = 1.06–3.93] and rectal surgery (OR = 2.35; 95% CI = 1.28–4.31) as independent risk factors for SSI. IBD surgery was not an independent risk factor for overall SSI (OR = 1.62; 95% CI = 0.94–2.80). However, there was a significant difference in the incidence of incisional SSI [IBD, 11.9% (UC, 12.7%; CD, 10.7%); CA, 4.9%, $p = 0.003$]. In the analysis of rectal surgery, the incidence of incisional SSI was 5.3% in CA patients, 12.0% in UC patients, and 26.3% in CD patients. In contrast to overall SSI data, IBD surgery was found to be an independent risk factor for incisional SSI (OR = 2.59; 95% CI = 1.34–5.03).
Conclusions In patients of surgery restricted to clean-contaminated wounds, IBD was shown to be an independent risk factor for incisional SSI. With the use of proper operative procedures and techniques, the incidence of organ/space SSI should not be high in patients who undergo an uncomplicated IBD surgical procedure.

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Introduction

Surgical site infection (SSI) is the second or third most common type of nosocomial infection and has been reported to increase medical costs and the length of hospital stays [1–3]. The rate of SSI for patients undergoing intestinal surgery generally ranges from 3 to 38% in various reports, with a number of related factors shown to be associated with increased risk [4–9]. Some of the extensively described conditions in those reports include diabetes mellitus, perioperative blood transfusion, advanced age, malnutrition, construction of ostomy, and an American Society of Anesthesiologist (ASA) score greater than 3 points, while colorectal surgery is also known to be associated with an increased risk of SSI, especially in patients undergoing rectal surgery.

On the other hand, surgery for inflammatory bowel disease (IBD) is frequently performed in patients with factors suspected to increase the risk of SSI, such as the preoperative presence of abdominal abscesses or peritonitis, intestinal obstruction, impaired nutritional status, and chronic therapy with steroid or immunosuppressive agents. Such conditions are manifested with high frequency in SSI cases, and relatively high rates of SSI have been reported for patients with Crohn's disease (CD) and ulcerative colitis (UC) [10–22].

It is generally believed that the accompanying conditions in IBD patients, such as poor nutritional status and administration of immunosuppressive agents, are associated with a high incidence of SSI, and sometimes these patients are classified as compromised hosts without definitive clinical evidence. In addition to impaired host defense, higher incidences of contaminated or dirty/infected wounds are related to IBD surgery, such as the preoperative presence of abdominal abscesses or peritonitis. In addition, surgery for an intestinal obstruction, in contrast to colorectal cancer surgery, is considered to be another reason for the high rate of SSI in IBD patients who underwent surgery. Therefore, to assess the influence of a patient's condition on the occurrence of SSI in cases of IBD, evaluation of the SSI rate in surgical patients restricted to clean-contaminated wounds is considered important.

As for other causes for the high SSI rate in IBD surgery, many authors have emphasized the high rate of organ/space SSI, including anastomotic failures in IBD surgery. Another concern is that IBD surgery may be a risk factor for incisional SSI. In general, a number of factors, in addition to a patient's condition, such as the operative procedures and technical ability of the surgeon are related to the occurrence of suture insufficiency. To investigate the relationship between the occurrence of SSI and impaired host defense mechanism in patients with IBD, evaluation of SSI confined to the incision is thought to be useful. In the present study we investigated the incidence of SSI following surgery in clean-contaminated wounds and compared the results between patients with IBD and those with colorectal cancer (CA) to clarify the impact of IBD on the occurrence and features of SSI.

Methods

A total of 580 patients (348 males, 232 females; 177 with UC, 130 with CD, 273 with CA) who underwent a laparotomy for IBD or CA at Hyogo College of Medicine between March 2006 and December 2007 were included in this study. Possible factors for SSI, which were duration of surgery $\geq$3 h, construction of ostomy, corticosteroid administration, immunosuppressant administration, total steroid dose $\geq$10,000 mg (converted to predonisolone), diabetes mellitus, smoking habit, blood transfusion, ASA score $\geq$3, serum albumin level $\geq$3.0 g/dl, postoperative blood sugar level $\geq$200 mg/dl, body mass index (BMI) < 18, BMI $\geq$ 25, preoperative hospital stay $\geq$6 days, emergency surgery, IBD surgery, and rectal surgery (REC), were analyzed by univariate and multivariate logistic regression analyses to determine the predictive significance of those variables.

For comparisons of factors associated with SSI, we used the National Nosocomial Infection Surveillance (NNIS) risk index, which is composed of ASA score $\geq$3, wound classification $\geq$3, and duration of surgery $\geq$3 h [23]. The surgical wounds were also classified using the NNIS system; however, becauses dirty and contaminated wounds were excluded from our study, wound classification was limited to class 2 (clean-contaminated) and the risk index was divided into three grades ranging from 0 to 2.

The diagnosis of SSI was made by our infection control team based on definitions stated in the guidelines issued by the NNIS system. Patients were followed for at least 30 days postoperatively [3]. The primary finding was the incidence of SSI. Criteria for a diagnosis of incisional SSI were an infection that occurred within 30 days after the operation involving the skin, subcutaneous tissue, or deep soft tissue (e.g., fascia and muscle layers) at the incision site, and at least one of the following: (1) purulent drainage from the incision, with or without laboratory confirmation; (2) organisms isolated from an aseptically obtained culture of fluid or tissue taken from the incision site; (3) at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, heat, or fever ($\geq$38°C); (4) spontaneous wound opening; and (5) abscess or other evidence of infection involving the fascia or muscle layer found on direct examination, during a reoperation, or by histopathologic or radiologic examination. The criterion for diagnosis of organ/space SSI was an infection that occurred within 30 days after the operation involving the intra-abdominal cavity.

Each patient was classified into the CA, UC, or CD group. The surgical site was classified as colonic surgery (COLN) or rectal surgery (REC), which was defined as a procedure that included manipulation above or below, respectively, the peritoneal reflection. Elective operations for UC at our hospital include a total colectomy, mucosal proctectomy, and hand-sewn ileal J pouch anal anastomosis (IPAA); those cases were classified as REC. Cases with dirty or infectious conditions such as contamination with toxic megacolon or perforate peritonitis and those with an infectious anorectal lesion with CD and cases with closure of covering ileostomy were excluded from this study.

According to our hospital's protocol, all patients who underwent elective procedures for UC and CA received

mechanical preparation with oral laxatives and a glycerin enema. In patients with CD, mechanical preparation was not performed because of intestinal stricture. Second-generation cephalosporin as a prophylactic antibiotic (20 mg/kg) was administered 30 min before the incision, repeated every 3 h during surgery, then stopped 24 h after the operation. Oral antibiotics were administered on the day before surgery.

Statistical analysis

The incidence of SSI correlated with the perioperative variables. The relative risks and 95% confidence intervals for all the variables were calculated and potential confounders were examined by cross tabulation. A χ^2 test for categorical data and *t* test for variables with normal distribution were used to assess the difference between the means. The level of statistical significance was set at $p < 0.05$. Univariate analyses of categorical data and each individual factor were also conducted. All variables with a relative risk greater than 1.3 were subsequently entered into a stepwise logistic regression model. SPSS ver. 15.0 (SPSS Inc., Chicago, IL) was used to perform all analyses.

Results

At the end of the study period we analyzed 562 cases with a clean-contaminated wound (333 males, 229 females). These cases consisted of 267 patients with CA (COLN, 98; REC, 169), 173 with UC (COLN, 6; REC, 167), and 122 with CD (COLN, 103; REC, 19), while 18 patients with dirty or contaminated wounds were excluded. One patient with indeterminate colitis (IC), whose diagnosis was changed to CD from UC after IPAA surgery, was included in the UC group. The mean age of all patients was 51.0 years (range = 13–93). Patient demographics and clinical characteristics are given in Table 1. There were no significant differences for length of operation and risk index between CA and IBD, whereas IBD patients were younger than those with CA. The rates of emergency surgery were 2.6% (7/267) of patients with CA and 9.2% (27/295) of those with IBD, which was significantly different ($p < 0.01$).

The overall incidence rate of SSI was 12.6% (71/562), while it was 10.9% (29/267) for patients with CA and 14.2% (42/295) for those with IBD. There were no significant differences in SSI rate among the diseases [(UC, 14.5% (25/173); CD, 13.9% (17/122); CA, 10.9% (29/267)]. In our analysis of infection site, the incidence of incisional SSI was 4.9% (13/267) in patients with CA and 11.9% (35/295) in those with IBD ($p = 0.003$) (UC, 12.7%; CD, 10.7%), while the incidence of organ/space SSI was 6.0% (16/267) in patients with CA and 2.4% (7/295) in those with IBD ($p < 0.01$).

Because of the extremely low number of colonic surgeries performed in patients with UC in the present study, we were unable to determine a tendency in a comparison of SSI between colon cancer and IBD surgery [UC, 33.3% (2/6); CD, 8.7% (9/103); CA, 4.1% (14/98)]. In our analysis of patients who underwent rectal surgery (Fig. 1), the rates of SSI were similar between CA and UC patients, whereas those with CD had a significantly higher incidence. The incidence of incisional SSI was 5.3% in CA patients, 12% in UC patients, and 26.3% in CD patients, which revealed a significant difference between CA and IBD ($p = 0.009$). As for organ/space SSI, the incidence in UC patients was significantly lower than in CA and CD patients ($p < 0.01$). All instances of organ/space SSI in UC patients were caused by anastomotic failure at the site of the ileal J pouch. In patients with CD, organ/space SSI was caused by anastomotic failure in two patients and an intraabdominal abscess in one.

Table 1 Demographics and clinical characteristics

	Colorectal cancer ($n = 267$)	Inflammatory bowel disease ($n = 295$)	p value
Gender (male/female)	163/104	170/125	0.41
Age (years) [median (interquartile range)]	65 (19–95)	36 (13–79)	<0.01
Operation time (min)	214.5 ± 92.6	208.2 ± 74.3	0.27
Risk index			
−1	0.4% (1/267)	0% (0/295)	0.39
0	52.4% (140/267)	56.3% (166/295)	
1	42.3% (113/267)	41.7% (123/295)	
2	4.9% (13/267)	2.0% (6/295)	
Emergency surgery	2.6% (7/267)	9.2% (27/295)	<0.01
Construction of ostomy	35.6% (95/267)	59.3% (175/295)	<0.01
Corticosteroid administration	2.2% (6/267)	62.4% (184/295)	<0.01

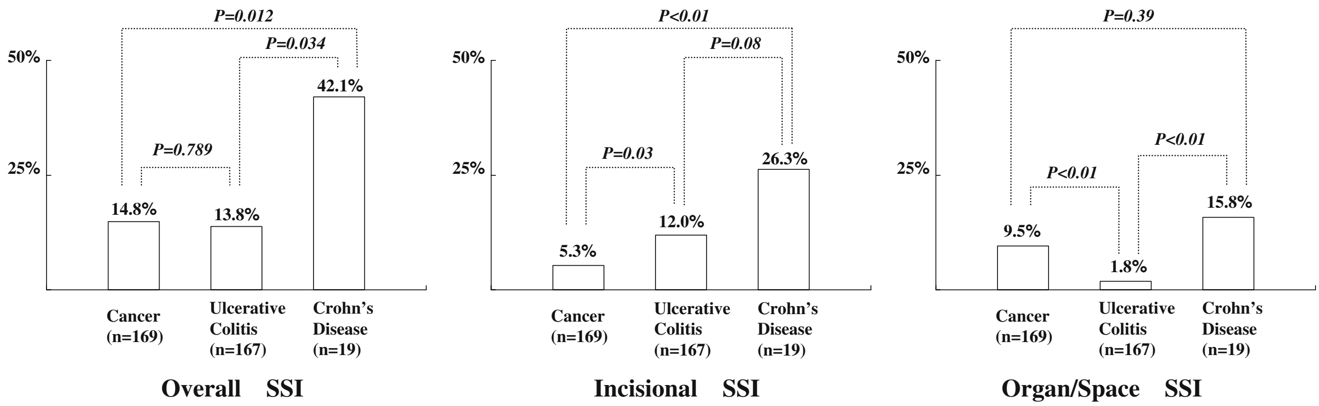

Fig. 1 SSI incidence of rectal surgery. The percentage values are the incidence rates of SSI with respect to disease [rectal cancer (CA), ulcerative colitis (UC), and Crohn's disease (CD)]. In our analysis of rectal surgery, the incidence of SSI in CD cases (42.1%) was higher than that in the others (CA, 14.8%; UC, 13.8%). Organ/space SSI had a much lower rate of incidence in patients with UC, while that of incisional SSI was much higher in those who underwent UC and CD surgery

Results of univariate analyses of variables potentially associated with SSI are presented in Table 2. From those, the following nine variables were included in multivariate logistic regression analysis: duration of surgery ≥3 h, construction of ostomy, total steroids ≥10,000 mg, BMI ≥ 25, ASA score ≥3, preoperative hospital stay ≥6 days, IBD surgery, REC surgery, and blood transfusion. The results of univariate analysis of variables potentially associated with incisional SSI are presented in Table 3. From those, the following seven variables were included in multivariate logistic regression analysis: duration of surgery ≥3 h, construction of ostomy, total steroids ≥10,000 mg, blood transfusion, ASA score ≥3, IBD surgery, and REC surgery. In a stepwise logistic regression model, duration of preoperative hospital stay (OR = 1.733, 95% CI = 1.007–2.980, p = 0.047) and construction of ostomy (OR = 3.405, 95% CI = 1.948–5.952, p < 0.001) were selected as risk factors for SSI, while only

Table 2 Univariate logistic regression analysis for risk factors associated with overall SSI

Variables	p value	Relative risk (95% CI)
Duration of surgery ≥3 h	0.060	1.649 (0.994–2.734)
Construction of ostomy	<0.001	3.427 (1.968–5.969)
Administration of steroid	0.887	1.056 (0.607–1.837)
Administration of immunosuppressant	0.740	1.157 (0.332–4.031)
Total steroids ≥10,000 mg	0.296	1.667 (0.692–4.013)
Diabetes mellitus	1.000	0.987 (0.287–3.399)
Smoking	0.426	0.741 (0.375–1.463)
Blood transfusion	0.349	1.536 (0.626–3.768)
ASA score ≥ 3	0.162	1.558 (0.836–2.904)
Alubumin < 3.0 g/dl	1.000	0.986 (0.598–1.626)
Blood sugar ≥ 200 mg/dl	1.000	1.018 (0.385–2.696)
BMI (kg/m^2) < 18	0.124	0.513 (0.227–1.157)
BMI (kg/m^2) ≥ 25	0.101	1.826 (0.919–3.631)
Preoperative hospital stay ≥6 days	0.082	1.639 (0.967–2.780)
Emergency surgery	0.956	1.027 (0.402–2.623)
IBD	0.254	1.362 (0.822–2.258)
REC	0.004	2.397 (1.318–4.359)

SSI surgical site infection, *CI* confidence interval, *ASA* American Society of Anesthesiologists, *BMI* body mass index, *IBD* inflammatory bowel disease, *REC* rectal surgery

Table 3 Univariate logistic regression analysis for risk factors associated with incisional SSI

Variables	p value	Relative risk (95% CI)
Duration of surgery ≥3 h	0.149	1.616 (0.887–2.943)
Construction of ostomy	<0.001	5.309 (2.519–11.186)
Administration of steroid	0.501	1.283 (0.653–2.350)
Administration of immunosuppressant	0.699	1.130 (0.255–5.006)
Total steroids ≥10,000 mg	0.352	1.760 (0.655–4.729)
Diabetes mellitus	0.712	0.454 (0.060–3.439)
Smoking	0.254	0.574 (0.238–1.388)
Blood transfusion	0.275	1.780 (0.631–5.017)
ASA score ≥ 3	0.529	1.301 (0.605–2.796)
Alubumin < 3.0 g/dl	0.763	1.118 (0.618–2.022)
Blood sugar ≥ 200 mg/dl	1.000	0.885 (0.262–2.989)
BMI (kg/m^2) < 18	0.153	0.432 (0.151–1.233)
BMI (kg/m^2) ≥ 25	0.633	1.187 (0.483–2.920)
Preoperative hospital stay ≥6 days	0.732	0.824 (0.409–1.669)
Emergency surgery	0.440	0.683 (0.264–1.770)
IBD	0.004	2.630 (1.360–5.087)
REC	0.161	1.632 (0.843–3.161)

SSI surgical site infection, *CI* confidence interval, *ASA* American Society of Anesthesiologists, *BMI* body mass index, *IBD* inflammatory bowel disease, *REC* rectal surgery

Table 4 Multivariate logistic regression analysis for risk factors associated with SSI

	Stepwise logistic regression model for	Variables	*p* value	Odds ratio (95% CI)
Incisional and organ/space SSI	9 variables	Preoperative hospital stay ≥6 days	0.047	1.733 (1.007–2.980)
		Construction of ostomy	<0.001	3.405 (1.948–5.952)
	7 variables[a]	ASA score ≥3	0.033	2.040 (1.059–3.930)
		REC	0.006	2.345 (1.276–4.307)
		IBD	0.082	1.624 (0.940–2.804)
Incisional SSI	7 variables	Construction of ostomy	<0.001	4.489 (2.099–9.599)
	5 variables[a]	IBD	0.005	2.593 (1.336–5.034)

SSI surgical site infection; *CI* confidence interval; *ASA* American Society of Anesthesiologist, *IBD* inflammatory bowel disease, *REC* rectal surgery

[a] Construction of ostomy and administration of steroid were excluded to eliminate the influence by confounding factors

construction of ostomy (OR = 4.489, 95% CI = 2.099–9.599, $p < 0.001$) was selected as a risk factor for incisional SSI. In this analysis, IBD was not revealed to be an independent risk factor. The odds ratios were 1.23 (95% CI = 0.646–2.346) for SSI and 1.85 (95% CI = 0.846–4.407) for incisional SSI in the IBD cases.

Because of extremely high concomitant tendencies between steroid administration and IBD (86.1%) and between construction of ostomy and REC (86.3%), construction of ostomy and administration of steroids were excluded from analysis in order to eliminate the influence of those confounding factors. Consequently, results of stepwise logistic regression analysis without those variables revealed ASA (OR = 2.04, 95% CI = 1.059–3.930) and REC (OR = 2.345, 95% CI = 1.276–4.307) as risk factors for SSI. The odds ratio for IBD was 1.624 (95% CI = 0.940–2.804, $p = 0.082$), which was not statistically significant. As for incisional SSI, IBD (OR = 2.593, 95% CI = 1.336–5.034, $p = 0.005$) was shown to be a significant independent risk factor (Table 4).

Discussion

There are a number of problems associated with SSI, such as increases in medical treatment costs, extension of hospitalization, and lower levels of patient satisfaction. At our hospital, one of the main centers of IBD treatment in Japan, surgeries for UC and CD comprise nearly half of the patients who undergo a colectomy. Along with factors related to a compromised host, such as administration of steroid and immunosuppressant agents, anemia and malnutrition are inevitable in the perioperative period of IBD surgery. In addition, with issues related to contaminated or dirty wounds often involved, it is believed that the incidence of SSI is greater in IBD surgery than other types of ordinary surgery of the large intestine. A number of studies have reported various rates of incidence for incisional SSI ranging from 5.8 to 47.1% and for organ/space SSI ranging from 5 to 18.6% in UC and CD patients [10–22]. However, those reports included cases with contaminated or dirty wounds, and there are no clear data regarding the influence of host conditions on SSI in cases of IBD surgery. In the present study we investigated whether IBD surgery is a factor for SSI in patients with clean-contaminated wounds.

The independent risk factors for overall SSI were found to be ASA score ≥3 and REC, whereas surgery for IBD and factors related to impaired host defense mechanism, such as administration of steroids, anemia, and malnutrition, were not selected. In our analysis of SSI confined to incisions, IBD surgery was revealed to be a unique independent risk factor. In the clean-contaminated wound cases in this study, the rates of intra-abdominal abscesses and anastomotic failure were not significantly greater in patients who underwent IBD surgery.

Significant differences in SSI incidence were observed between CA and IBD patients in regard to the site of infection. We considered that preoperative chemoradiation treatments may be related to the high incidence of organ/space SSI in patients of CA. On the other hand, the influences of impaired host defense, emergency surgery, construction of ostomy, and dose of steroids may be related to the high incidence of incisional SSI in IBD cases. Actually, the rate of emergency surgery for IBD was much higher than that for CA. In this study, the indications for emergency surgery were generally massive bleeding, intestinal obstruction, or severe disease activity since the cases with dirty or contaminated wounds were excluded. Because of relatively low SSI risk in emergency surgery in our study, we did not include this factor for multivariate analysis. Therefore, we considered that high rate of emergency surgery in IBD did not influence the result.

Although comparative data with other diseases such as colorectal cancer are limited, some authors have reported a high incidence of SSI in patients with IBD and emphasized the risk of organ/space SSI, including anastomotic failure.

Table 5 SSI incidence of previous reports and this study

First author [ref.]	Disease	No. patients	Incidence of incisional SSI (%)	Incidence of organ/space SSI (%)	
				Pelvic sepsis	Anastomotic leakage
Alves [20]	Crohn's disease	161	6.8	9.8	–
Yamamoto [21]		566	6.0	10.0	–
Colombel [22]		270	10.0	5.0	3.0
Our study		122	9.8	4.1	–
Fazio [12]	Ulcerative colitis	1005	5.8	18.1	–
Sagap [13]		2518	–	6.2	–
Madbouly [14]		1202	8.5	7.9	–
Cohen [15]		483	–	3.0	12.0
Fukushima [16]		197	–	9.1	–
Farouk [17]		1508	–	4.8	–
Wettergren [18]		144	–	–	13.0
Lovegrove [19]		4183	–	5.8	6.9
Our study		173	13.3	1.2	0

SSI surgical site infection

Other previous analyses of SSI with CD surgery are summarized in Table 5. The SSI rates of CD surgery were higher than general colorectal surgery. In the present study of patients with clean-contaminated wounds, those with CD who underwent rectal surgery had a high incidence of SSI, similar to those reports.

The various SSI rates of UC surgery reported previously are also summarized in Table 5. A meta-analysis of 4183 patients reported incidence rates of 6.9 and 5.8% for anastomotic leakage and pelvic abscess, respectively [19]. In contrast, the incidence of organ/space SSI in our series was much lower than in those reports. The incidence of intrapelvic infection after pouch surgery in other studies is higher than that in our study, which is considered to be related to the high frequency of patients with indeterminate colitis (IC) who were highly likely to have CD, and the high frequency of stapled IPAA cases. In our series, only one patient was diagnosed with IC and most IPAA cases had hand-sewn procedures performed. Fazio et al. [12] reported that the incidence rate in IC patients was 7.5% and also noted that 67% of their IPAA patients underwent stapled IPAA. Sagap et al. [13] reported that the final pathologic diagnoses of patients with IC or CD, which accounted for 25% of 157 cases of pelvic sepsis that occurred in 2518 patients who underwent pouch surgery. As for the method of IPAA, a hand-sewn IPAA was routinely performed in our series, which may be another reason why the incidence of organ/space SSI was low in our UC patients. In fact, none of the patients had an anastomotic failure at the site of the hand-sewn IPAA. Ikeuchi et al. [24] reported that anastomotic failure at the site of a hand-sewn IPAA was low at 2% and failures at the intermediate or proximal cut end of the ileal J pouch amounted to 4%. Dayton et al. [25] also reported that only 2% of their cases experienced anastomotic failure and 11% pouch leakage, while another study suggested that suture failure was more frequent in patients who underwent stapled IPAA than hand-sewn IPAA [26]. Although no significant difference in the incidence of postoperative complications was identified between hand-sewn and stapled IPAA by meta-analysis, when skilled surgeons perform hand-sewn procedures, suture insufficiency may be lower.

In conclusion, in cases of surgery restricted to clean-contaminated wounds, IBD was shown to be an independent risk factor for incisional SSI. With the use of proper operative procedures and techniques, the incidence of organ/space SSI should not be high in patients who undergo an uncomplicated IBD surgical procedure.

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